Article title

Differences in pre-conception and pregnancy healthy lifestyle advice by maternal BMI: findings from a cross sectional survey

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HIGHLIGHTS

- Low maternal BMI is associated with adverse outcomes, however guidance is limited
- Underweight pregnant women did not receive as much advice as women with high BMIs
- Alcohol consumption and smoking were relatively common in underweight pregnant women
- Evidence is needed to inform care recommendations for underweight pregnant women

ABSTRACT

Objective
Being underweight at pregnancy commencement is associated with a range of adverse maternal and infant outcomes, as is being overweight or obese, yet it is an aspect of maternal health which has been relatively neglected by healthcare professionals and researchers. We aimed to investigate differences in pre-pregnancy and pregnancy healthy lifestyle advice routinely offered by relevant healthcare professionals, including midwives and GPs, to women across three different BMI categories – underweight, normal, and overweight or obese.

Design
A cross-sectional study nested in an antenatal survey of pregnant women.

Setting
Antenatal clinics of three National Health Service (NHS) hospitals in London, UK.

Participants

Pregnant women at any gestation of pregnancy were invited to participate in the study whilst attending a routine antenatal scan appointment.

Measurements

Main outcomes of interest were whether women had sought and/or had been offered healthy lifestyle advice by relevant healthcare professionals before or during the index pregnancy and whether the advice offered had included weight management, tobacco smoking cessation and alcohol intake. Other outcomes included alcohol consumption and tobacco smoking before and during the index pregnancy.

Findings

A total of 1173 women completed the survey, with pre-pregnancy BMI data available for 918 (78.3%) women, 632 (69%) of whom were of normal weight, 232 (25%) were overweight or obese, and 54 (6%) were underweight. Overall, 253 (28%) of these women reported they had sought pre-conception advice. Women with a low BMI were offered pre-pregnancy and pregnancy healthy lifestyle advice of a similar content to women with a normal BMI, whereas women with a high BMI were more likely to be offered specific pre-conception and pregnancy advice on healthy BMI (respectively OR 2.55; 95% CI 1.64-3.96: OR 1.79; 95% CI 1.26-2.54), pre-conception healthy diet (OR 1.58; 95% CI 1.06-2.37), reducing alcohol consumption (OR 1.63; 95% CI 1.06-2.51) and smoking cessation (OR 1.62; 95% CI 1.05-2.50). For all women, reported alcohol consumption during pregnancy was lower than pre-conception, but within each BMI group around half of the women reported consuming alcohol at some time during their pregnancy.

Key conclusions

Women with a low BMI are no more likely than women with a normal BMI to be advised by health professionals about a healthy lifestyle or a healthy weight for their height before or during pregnancy. In contrast women with a high BMI are more likely to receive such advice. Provision of pre-conception care could provide opportunity to advise women across the weight spectrum of the importance of adopting a healthy lifestyle for optimal pregnancy outcomes, as well as consider management of any pre-existing medical conditions.

Implications for practice

Healthy lifestyle advice, including alcohol consumption and smoking cessation, should be offered to women who are underweight before and during pregnancy as well as to women who are overweight or obese, to improve adherence to recommendations to optimise maternal and infant outcomes. Advice should also be tailored to reflect women's ethnic background, which could be an important influence on lifestyle behaviour and weight management. The potential clinical benefit of routine provision of pre-conception care, particularly for women who have a high risk of a poorer pregnancy outcome due to weight status or other medical complications, needs to be explored.

KEY WORDS

Body Mass Index, Midwifery, Maternal Health, Pregnancy, Antenatal Care, Pre-conception advice

INTRODUCTION

Background

A BMI of less than 18.5 is considered underweight (World Health Organization, 2006), with around 7.6% of women pre-conception (Jeric et al., 2012) and 3.8% in pregnancy (Abayomi et al., 2007) identified as underweight in previous observational studies. Underweight is not as prevalent as overweight or obesity in pregnancy (Abayomi et al., 2007), and subsequently it has received much less attention in the literature. Nonetheless low maternal BMI is similarly associated with adverse maternal and infant outcomes, such as increased risk of infertility (Kumar et al., 2013), miscarriage (Feodor Nilsson et al., 2014; Helgstrand and Andersen, 2005), intrauterine fetal growth restriction (Doherty et al., 2006; Ehrenberg et al., 2003), prematurity (Han et al., 2011; Kosa et al., 2011; Rahman et al., 2015), low birth weight (Rahman et al., 2015) and having small for gestational age babies (Han et al., 2011; Jeric et al., 2012; Rahman et al., 2015; Sekiya et al., 2007). Furthermore, a low BMI is associated with poorer general health (Ford et al., 2001; Molarius et al., 2009; Norman and Fraser, 2013; World Health Organization, 2002) and unhealthy lifestyle choices such as tobacco smoking (Audrain-McGovern and Benowitz, 2011), which further increase perinatal risk (Voigt et al., 2011).

In UK settings where the majority of maternity care is provided within the National Health Service (NHS), a tax-funded public healthcare system with care provided free at the point of access, the National Institute for Health and Care Excellence (NICE) guidelines for maternity

care recommend women achieve a healthy pre-pregnancy weight and adhere to a healthy lifestyle to optimise maternal and infant outcomes (NICE, 2008a, 2008b, 2010). The guidance is consistent with general population recommendations on healthy BMI, healthy diet, avoiding tobacco smoking, and limiting alcohol consumption. Although there is no known safe amount of alcohol that women should consume pre-conception or during pregnancy, continued intake of alcohol during pregnancy can also increase risk of poor perinatal outcomes (NICE, 2008a; Nykjaer et al., 2014). Despite evidence of adverse maternal and infant outcomes associated with maternal underweight, NICE does not currently include specific guidance for these women before, during or after pregnancy, which could potentially improve outcomes of the index pregnancy as well as any future pregnancies.

In contrast, NICE has developed specific guidance for health professionals to advise overweight or obese women on weight management before, during and after pregnancy (NICE, 2006, 2008a, 2008b, 2010). This guidance does not include recommendations on appropriate gestational weight gain due to the absence of evidence for UK populations, and concerns that the Institute of Medicine guidance (Institute of Medicine, 2009) would not be relevant to UK populations. There is no current routine NHS provision of pre-conception care, although women can access advice from their GPs, midwives, family planning clinic or well-woman clinic should they wish to do so. Women with certain pre-existing medical conditions such as cardiac disease or diabetes may also be offered pre-conception counselling with limited evidence of benefit (Bick et al., 2014).

There is some evidence that health professionals are more likely to offer pre-pregnancy and pregnancy healthy diet advice to women who are overweight and obese than to women of normal weight (Yamamoto et al., 2013). However, other studies have not found any differences in the content of healthy diet and tobacco smoking cessation advice from health professionals offered to pregnant women with different BMI classifications (Brown and Avery, 2012; Hardy et al., 2014). No previous studies have compared the content of pre-conception and pregnancy healthy lifestyle advice offered by health professionals to women underweight or overweight or obese compared with women of normal weight.

Objectives

To investigate differences in healthy lifestyle advice offered by health professionals to women across the BMI spectrum in the three months before conception and during pregnancy, as recalled by pregnant women.

METHODS

Study design

A cross-sectional study was undertaken, the full details of which are described in a previous publication (Stephenson et al., 2014). The details applicable to data presented in this paper are described below.

Setting

Women were recruited between November 2011 and May 2012 from antenatal scan clinics of three National Health Service (NHS) hospitals in London, UK. These hospitals were selected as women attending them represented diverse ethnic and socioeconomic backgrounds, as well as women classed with low or high risk pregnancies.

Participants

An opportunistic sample of pregnant women at any gestation of pregnancy at the time of invitation to participate, who were attending a routine antenatal scan at one of the three hospitals which took part in the study. To be considered eligible for the study women had to be capable of reading and completing the survey in English.

Procedure

Women at each study site were approached by trained researchers who offered them an information leaflet which explained the aims of the study and consent process. By completing the survey questionnaire, women's consent to participate was implied. The women were asked to complete the survey before leaving the antenatal scan clinic.

Variables

Predictor

Women provided self-report estimates of their height and pre-conception weight to enable calculation of their pre-conception BMI. Pre-conception BMI was calculated as weight (kg) divided by height in metres squared (m^2). Women were categorised in accordance with the

WHO classification system; underweight (BMI <18.5 kg/m^2), normal weight (BMI 18.5–24.9 kg/m^2), overweight (BMI 25.0-29.9), and obese (BMI≥30.0 kg/m^2) (World Health Organization, 2006).

Survey questions

Women were asked if they had actively sought pre-conception advice from a health professional (midwife, GP or any other health professional). They were not asked about their reasons for seeking this. Women were asked if at this time or any other time before their pregnancy, a health professional had offered them healthy lifestyle advice to consider and if healthy lifestyle advice had been offered at any time to consider during pregnancy. Healthy lifestyle advice of interest included if women were offered advice on a healthy BMI, what a healthy diet before and during pregnancy should include, advice on abstinence or reduction of alcohol consumption and tobacco smoking cessation. Women were asked to provide details of alcohol and tobacco smoking behaviours in the three months before conception and since becoming pregnant. Women's responses to questions were treated as dichotomous.

Socio-demographic, obstetric and other health data

Demographic and obstetric details collected included women's age, ethnicity, employment status, education, expected date of delivery, parity, and history of previous pregnancy losses. The gestation of the index pregnancy in weeks was calculated from the expected date of delivery, and women were categorised as being in the first (<12 weeks), second (13-28 weeks) or third trimester (>29 weeks) of pregnancy. The London Measure of Unplanned Pregnancy (LMUP; Barrett, 2004) was included in the survey to assess the extent to which the index pregnancy had been planned. This is a six-item validated questionnaire that produces a score of 0-12, which is categorised as 'unplanned' (a score of 0-3), 'ambivalent' (a score of 4-9), and 'planned' (a score of 10-12).

Women's general health at the time of survey completion was assessed using a four-level Likert scale rating from 'poor' to 'excellent', and responses dichotomised as 'good to excellent' and 'poor to fair'. Women were asked to report any medical conditions they suffered from at least three months prior to conception. These were classed as 'relevant medical conditions' if it could impact on or complicate the index pregnancy and medical review prior to conception would have been recommended.

Sample size

The data presented in this paper presents the analysis of a subset of women who took part in an antenatal survey of how women prepare for pregnancy published previously (Stephenson et al., 2014). Stephenson et al. previously calculated that a minimum of 1000 women would be needed to achieve at least 80% power to detect differences in key outcomes of interest at the 5% significance level for the key outcomes of interest (Stephenson et al., 2014).

Statistical methods

To test associations between sample characteristics, alcohol consumption and tobacco smoking behaviours pre-conception and during pregnancy, and BMI, chi-squared tests were used (Table 1). Variables were treated as categorical and the categorisations used for the tests are those presented in the tables, with the exception of age and gestation which were treated as continuous. To calculate unadjusted and adjusted odds ratios (ORs) for pre-conception and pregnancy healthy lifestyle advice outcomes across BMI logistic regression was used, which are presented with 95% confidence intervals (Table 2). BMI is the key explanatory factor that was investigated in the regressions and was considered in 3 categories with the reference category being 'normal BMI'; all other participant characteristics were viewed as potential confounders. A priori confounders (age, education, ethnicity, and parity) i.e. factors known to be associated with BMI (Gaillard et al., 2013; Ogden et al., 2013) were adjusted for to generate adjusted ORs. Gestation was also treated as a potential confounder as there were more women in the third trimester of pregnancy with a high BMI compared to the other two BMI groups. The results were not additionally adjusted for employment status, as this was not only an additional measure of socio-economic status (in addition to education), but was also highly correlated with education ($r(895) = .24$, $P<0.0001$) and could potentially lead to statistical over adjustment. The same applied to miscarriage history, which was an additional measure of obstetric history (in addition to parity), and highly correlated with parity ($r(792) = .25$, $P<0.0001$) and again could lead to statistical over adjustment. We chose not to exclude women on the basis of a pre-existing medical condition or self-reported general health as the sample was intended to reflect low and high risk pregnancies and there is no evidence to suggest that women with medical complications are offered advice which is any different to women who do not have any complications before or during pregnancy (Bick et al., 2014). Supplementary to the main outcomes, associations between pre-conception healthy lifestyle advice and BMI, for women that visited a health professional for conception advice, were tested using chi-squared tests (Supplementary Table 1). All analyses were conducted on SPSS Statistics 22 for

Windows (SPSS Inc.) and a two-tailed significance level of $p \leq .05$ used. Due to the small sample size the significance level was not adjusted for multiple comparisons as this could have increased the risk of over-correction. The frequency of missing outcome data, ranged between 0.0%-2.2% due to missing data on single items. Given low percentages of missing data we carried out complete case analyses.

FINDINGS

Participants

A response rate of 91% (86%, 91% and 94% at the three sites) was achieved from women who met inclusion criteria, who were asked and agreed to participate in the study, resulting in a total of 1173 women who completed the antenatal survey. Pre-pregnancy BMI data were available for 918 (78.3%) women whose data are presented here, 632 (69%) of whom were classed as having a normal BMI, 232 (25%) as having a high BMI (154 women had a BMI of 25.0-29.9 kg/m^2 and 78 had a BMI$\geq$30.0 kg/m^2), and 54 (6%) with a low BMI, 16 (30%) of whom had a BMI below 17.5. For study purposes the overweight and obese categories were combined as both include ranges of weight considered suboptimal for healthy pregnancy and birth outcomes (Yan, 2015). The women who were of normal weight had a median BMI of 21.6 (IQR=20.4-22.9), the women who were overweight or obese had a median BMI of 28.3 (IQR=26.4-31.0), and the women who were underweight had a median BMI of 17.7 (IQR=17.3-18.2).

Sample characteristics

Table 1 shows the distribution of sample characteristics by BMI group. Maternal age was similar in all three groups and the majority of women classed themselves as white European or white other. There was a higher proportion of women of South Asian and mixed ethnicity in the low BMI group, and a higher proportion of women of black African or black Caribbean origin in the high BMI group.

Women in the high BMI group were more likely to be in the third trimester of pregnancy at the time of completing the survey, were more likely to be multiparous and to have experienced a previous pregnancy loss in comparison to women in the other two BMI groups. They were also less likely to be in full-time employment or education.

Pregnancy planning as assessed using The London Measure of Unplanned Pregnancy (LMUP; Barrett, 2004) was high in all three groups and although not statistically significant, rates of planning were marginally higher in the low BMI group. Women in the low and high BMI groups were more likely to report their general health as poorer at the time of completing the survey compared to women of normal BMI. A quarter of the overall sample had a medical condition prior to pregnancy, with conditions reported including acne rosacea, asthma, bipolar disorder, chlamydia, depression, diabetes, epilepsy, cardiac disease, HIV, hypertension, kidney disease, lung disease, lupus, phenylketonuria (PKU), rheumatoid arthritis, sickle cell anaemia, and thyroid disease.

Table 1 inserted here

Main results

Table 2 shows the frequencies *and* crude and adjusted associations of pre-conception and pregnancy advice offered to women across BMI categories. A total of 253 (28%) women across BMI categories had sought pre-conception advice; 38% (n=20) of women who had a low BMI, 28% (n=173) of women with a normal BMI, and 23% (n=52) with a high BMI. Differences in seeking pre-conception advice were not statistically significant across BMI categories. And amongst these women who sought advice, there were not statistically significant differences in receiving healthy lifestyle advice across BMI categories, and there were a higher proportion that received healthy lifestyle advice in comparison to women who did not seek conception advice (see Supplementary Table 1).

Of the overall sample, 246 (27%) women were offered healthy lifestyle advice of interest pre-conception, 153 (24%) of whom had a normal BMI, 76 (33%) a high BMI, and 17 (32%) a low BMI. Women with a high BMI were more likely to receive advice pre-conception compared to women of normal weight (OR 1.61, 95% CI 1.13-2.30, p=0.009), however women with a low BMI had similar odds to women of normal weight. Further, 652 (71%) women were offered any healthy lifestyle advice *during* pregnancy, 440 (70%) women with a normal BMI, 172 (74%) with a high BMI, and 40 (74%) with a low BMI, and this did not differ significantly across BMI categories.

When considering the specific findings by BMI group, women in the low BMI group had similar odds to women of normal BMI of receiving healthy lifestyle advice, although they had

higher odds of being offered advice on alcohol consumption and smoking cessation but not healthy BMI or healthy diet, differences which were not statistically significant. In contrast, women in the high BMI group were more likely to be offered healthy lifestyle advice pre-conception in comparison to women with a normal BMI, associations which persisted after adjustment (healthy BMI: OR 2.55, 95% CI 1.64-3.96, p<.0001; healthy diet: OR 1.58, 95% CI 1.06-2.37, p=0.026; alcohol consumption: OR 1.63, 95% CI 1.06-2.51, p=0.026; smoking cessation: OR 1.62, 95% CI 1.05-2.50, p=0.029). Overweight or obese women were also more likely to receive healthy BMI advice during pregnancy, compared to normal weight women (OR 1.79; 95% CI 1.26-2.54; p=0.0001).

Table 2 inserted here

A high proportion of women in each BMI group had consumed alcohol in the three months before conception and at some time during the index pregnancy, although the frequency of alcohol intake pre-conception and during pregnancy was slightly lower in the high BMI group. Women in the low and high BMI groups were more likely to report smoking three months before conception and at some time during pregnancy, compared to women in the normal BMI group (Table 1).

DISCUSSION

Consistent with other pre-conception research (Frey and Files, 2006), around a third of the women for whom BMI data were available had sought pre-conception advice, although it is not known if this was *specifically* for advice on adopting a healthy lifestyle prior to conception in the absence of routine provision of pre-conception care in the UK NHS even for those who have pre-existing medical complications (Taylor et al., 2014). The findings suggest that irrespective of BMI, when women consulted for pre-conceptual advice they were more likely to be offered healthy lifestyle advice, but this needs to be explored further. The findings do show differences in the content of pre-conception and pregnancy healthy lifestyle advice offered by healthcare professionals to women in different BMI groups. We did not find differences between BMI groups on the extent of pregnancy planning (as measured by the LMUP) yet women who had a low BMI were offered pre-conception and pregnancy healthy lifestyle advice at similar levels as women of normal BMI, in contrast to women who had a high BMI, despite potential risks of poor pregnancy outcomes associated with a low BMI.

The prevalence of women with a low pre-pregnancy BMI in this study was similar to previous research (Jeric et al., 2012) and our findings highlight an important gap in healthcare guidance for the management of women with a low BMI at pregnancy commencement. Research in this area is limited with the majority of studies to date on health and lifestyle behaviours related to pregnancy focusing on women with high BMIs. We cannot exclude the possibility that these findings reflect other possible influences impacting on women's weight management, such as socio-economic and employment issues, but these possibilities are speculative and need to be explored further.

It is important that women with unhealthy BMIs, both low and high, receive timely advice on healthy BMI and diet to encourage these groups of women to achieve a healthy pre-conception BMI, with the potential to reduce the risk of adverse pregnancy outcomes (Simas et al., 2012). More research is needed to establish the most effective strategies for achieving a healthy pre- and post-pregnancy BMI and to determine what is an appropriate gestational weight gain for different groups of BMI women in the UK. The findings are particularly relevant to midwives who have the most frequent contact with women before, during and after pregnancy and are potentially able to identify women with an unhealthy BMI, and offer advice and refer for further support where deemed appropriate.

A higher proportion of women with a low BMI consumed alcohol before and during pregnancy, with rates similar to women with a normal BMI but slightly higher than women in the high BMI group. Our findings confirm previous study findings that many women continue to use alcohol during pregnancy (O'Keeffe et al., 2015), although we could not link outcomes with units drunk or frequency of intake. Women in the low and high BMI groups were more likely to smoke before and during pregnancy compared to women in the normal BMI group, a finding also reported previously (Audrain-McGovern and Benowitz, 2011). Interestingly, women in the low BMI group recalled being offered alcohol and smoking cessation advice at similar levels as women with a normal BMI, whereas women with a high BMI were more likely to recall being offered alcohol and smoking cessation advice *pre-conception* but not *during* pregnancy, although due to the small sub-group sizes findings should be treated with caution. We did not identify previous research on pre-conception alcohol and smoking cessation advice or pregnancy alcohol advice relevant to maternal BMI, but our findings on pregnancy smoking cessation advice are consistent with previous findings (Hardy et al., 2014).

Pre-conception and pregnancy alcohol intervention research is limited, although there may be potential benefit of advice on the importance of maintaining alcohol abstinence during pregnancy (Crawford-Williams et al., 2014; Gilinsky et al., 2011; Ingersoll et al., 2013). Smoking cessation research suggests women should be targeted in early pregnancy to optimise maternal and infant health benefits (Yan and Groothuis, 2013), with one recent study finding evidence of the efficacy of providing monetary incentives for pregnant women to quit smoking (Tappin et al., 2015). Our data suggest that smoking cessation interventions should also address healthy weight management to encourage women with low BMIs to quit smoking (Audrain-McGovern and Benowitz, 2011). Unhealthy BMI, alcohol consumption and tobacco smoking are all potentially modifiable risk factors to prevent adverse maternal and infant outcomes. Tailored support from the relevant health professionals and referral for timely and appropriate interventions to enable women to adopt and sustain healthy lifestyle behaviours are needed, including pre-conception.

Women in the low and high BMI groups rated their general health as significantly lower than women of normal BMI at the time of completing the survey. This is consistent with previous research (Ford et al., 2001; Norman and Fraser, 2013) and are not unexpected findings considering these BMI categories are associated with a range of health comorbidities (World Health Organization, 2002). Poor general health may affect motivation and perceived ability to adhere to healthy lifestyle recommendations (Wardle, 2003), which is an additional consideration for future guidance and clinical management of women who are underweight and planning pregnancy.

Strengths and limitations

The study has several strengths that warrant further consideration. Data on a range of relevant pre-conception and pregnancy outcomes were collected, with minimal missing data. Most importantly, this study has presented new evidence in terms of showing that about a third of women had sought pre-conception advice and that a quarter of women had a medical complication prior to becoming pregnant.

The interpretation of the study findings however needs to take limitations into account. The sample size recruited was slightly lower than originally calculated (Stephenson et al 2014) and the smaller number of women in the low BMI group limited the statistical power and

complexity of analysis. Therefore, findings should be interpreted with caution and replication in larger studies is required. We used self-reported height and weight as these are typically used in pregnancy research, although prone to measurement error as individuals tend to slightly overestimate their height and underestimate their weight (Brunner Huber, 2007; Rowland, 1990; Stommel and Schoenborn, 2009). Weight measurements taken at the initial antenatal 'booking' appointment are preferable although there is debate as to whether this is an accurate reflection of pre-pregnancy BMI as weight may already be confounded by the developing pregnancy and timing of the assessment.

There was unequal distribution of ethnicity between the BMI groups in our study and although ethnicity was included as a confounder in the analyses, more research is needed to replicate the findings with more ethnically diverse groupings and larger sample sizes. Furthermore, we did not have data on how often women visited a health professional before or during pregnancy. It is possible that women with a high BMI were more likely to have seen a health professional prior to pregnancy, for other health reasons associated with weight management, and were consequently more likely to receive healthy lifestyle advice. However low and high BMI are associated with a range of comorbidities meaning that women in both groups were just as likely to visit a health professional for reasons unrelated to pregnancy. Finally, the study relied on the recall of healthy lifestyle advice that women were offered. There is no obvious reason as to why level of recall should differ between women in the different BMI groups suggesting recall bias may have been limited, although it cannot be discounted.

Conclusion

Our study highlights an important gap in healthcare guidance for the management of women with a low BMI at pregnancy commencement. Low maternal BMI is associated with adverse pregnancy outcomes but has received substantially less attention than high maternal BMI in national guidance and practice. Robust evidence is now required to inform healthy lifestyle and clinical management guidance which addresses the gaps in the current evidence-base and can be tailored to meet individual women's needs. In the interim, health professionals need to be aware of the risk of adverse pregnancy outcomes for women who have a low BMI and the association with poor lifestyle choices.

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Ethics approval

Ethical approval for the survey was granted as part of the larger project, the Pre-Pregnancy Health & Care in England: Exploring Implementation and Public Health Impact, by the National Research Ethics Service, NRES Committee London - Bromley (REC reference 11/LO/0881).

494 **Table 1** Comparison of sample characteristics across the BMI categories[1]
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		All	BMI categories			
			Normal Weight	**Underweight**	**Overweight and Obese**	***P*-value**
Characteristics % (n)		**n=918**	**n=632**	**n=54**	**n=232**	
Age	**<30**	26 (234)	25 (152)	26 (13)	31 (69)	0.189
	30-34	42 (370)	43 (262)	51 (26)	36 (82)	
	35+	32 (285)	32 (198)	24 (12)	33 (75)	
Ethnic group	**White**	70 (630)	72 (448)	59 (31)	67 (151)	*P*<0.0001
	South Asian	11 (95)	10 (63)	25 (13)	8 (19)	
	Black	7 (66)	6 (34)	-	14 (32)	
	Mixed/other	12 (108)	12 (75)	17 (9)	11 (24)	
Employment status	**Employed or F/T education**	70 (639)	73 (457)	69 (37)	63 (145)	0.025
	Unemployed	8 (75)	7 (44)	13 (7)	10 (24)	
	At home or maternity	17 (158)	15 (96)	15 (8)	24 (54)	
	Other	4 (36)	5 (28)	4 (2)	3 (6)	
Education	**Degree**	70 (627)	73 (448)	79 (42)	60 (127)	0.005
	Diploma	17 (148)	15 (92)	13 (7)	22 (49)	
	Other	11 (101)	10 (62)	4 (2)	16 (37)	
	No qualifications	2 (22)	3 (16)	4 (2)	2 (4)	
Gestation	**First trimester**	42 (382)	45 (282)	46 (25)	33 (75)	0.004
	Second trimester	35 (322)	35 (216)	37 (20)	37 (86)	
	Third trimester	23 (207)	20 (128)	17 (9)	30 (70)	
Parity	**Primiparous**	61 (546)	64 (392)	72 (39)	51 (115)	0.001
	Multiparous	39 (346)	36 (221)	28 (15)	49 (110)	
Miscarriage history	**No**	73 (581)	76 (422)	78 (38)	63 (121)	0.003
	Yes	27 (216)	24 (135)	22 (11)	37 (70)	
Pregnancy intention	**Unplanned**	2 (21)	2 (14)	2 (1)	3 (6)	0.265
	Ambivalent	22 (204)	22 (136)	13 (7)	26 (61)	
	Planned	75 (685)	76 (474)	85 (46)	71 (165)	
General health	**Good to excellent**	93 (856)	97 (610)	89 (48)	85 (198)	*P*<0.0001
	Poor to fair	7 (62)	4 (22)	11 (6)	15 (34)	
Medical condition	**No**	86 (792)	88 (553)	89 (48)	82 (191)	0.125
	Yes	14 (126)	13 (79)	11 (6)	18 (41)	
Anxiety/mood	**No**	95 (876)	96 (606)	93 (50)	95 (220)	0.475
	Yes	5 (42)	4 (26)	7 (4)	5 (12)	
Alcohol before	**No**	31 (274)	29 (175)	29 (15)	38 (84)	0.043
	Yes	69 (611)	71 (436)	71 (36)	62 (139)	
Alcohol during	**No**	47 (409)	45 (269)	47 (24)	53 (116)	0.101
	Yes	53 (461)	55 (332)	53 (27)	47 (102)	
Smoking before	**No**	83 (743)	85 (523)	80 (43)	78 (177)	0.043
	Yes	17 (156)	15 (94)	20 (11)	22 (51)	

Smoking during	**No**	86 (743)	88 (523)	83 (43)	81 (177)	0.026
	Yes	14 (125)	12 (73)	17 (9)	20 (43)	

[1] BMI categories: underweight (<18.5 kg/m^2), normal weight (18.5–24.9 kg/m^2), overweight or obese (≥25 kg/m^2).

553 **Table 2** Frequencies and associations of pre-conception and pregnancy advice offered to women, across BMI
554 categories[1]
555

	BMI categories				
Outcome	**Normal**	**Underweight**	***P*-value**	**Overweight/Obese**	***P*-value**
Before pregnancy					
Conception advice					
% n	28 (173)	38 (20)		23 (52)	
OR (95% CI)	1 -	1.56 (0.87-2.80)	0.133	0.77 (0.54-1.10)	0.151
Adj OR (95% CI)	1 -	1.55 (0.83-2.89)	0.172	0.78 (0.52-1.16)	0.216
Any advice of interest					
% n	24 (153)	32 (17)		33 (76)	
OR (95% CI)	1 -	1.44 (0.79-2.63)	0.237	1.53 (1.10-2.12)	0.012
Adj OR (95% CI)	1 -	1.33 (0.70-2.53)	0.379	1.61 (1.13-2.30)	0.009
- Healthy BMI					
% n	10 (64)	9 (5)		22 (50)	
OR (95% CI)	1 -	0.91 (0.35-2.36)	0.839	2.44 (1.63-3.66)	*P*<0.0001
Adj OR (95% CI)	1 -	0.81 (0.28-2.36)	0.704	2.55 (1.64-3.96)	*P*<0.0001
- Healthy diet					
% n	17 (107)	19 (10)		24 (55)	
OR (95% CI)	1 -	1.12 (0.54-2.29)	0.766	1.53 (1.06-2.20)	0.024
Adj OR (95% CI)	1 -	0.93 (0.42-2.06)	0.860	1.58 (1.06-2.37)	0.026
- Alcohol					
% n	15 (94)	22 (12)		20 (47)	
OR (95% CI)	1 -	1.64 (0.83-3.22)	0.155	1.45 (0.99-2.14)	0.059
Adj OR (95% CI)	1 -	1.58 (0.77-3.25)	0.215	1.63 (1.06-2.51)	0.026
- Smoking					
% n	14 (90)	19 (10)		20 (46)	
OR (95% CI)	1 -	1.37 (0.67-2.82)	0.394	1.49 (1.01-2.21)	0.047
Adj OR (95% CI)	1 -	1.47 (0.70-3.08)	0.313	1.62 (1.05-2.50)	0.029
During pregnancy					
Any advice of interest					
% n	70 (440)	74 (40)		74 (172)	
OR (95% CI)	1 -	1.25 (0.66-2.35)	0.494	1.25 (0.89-1.76)	0.196
Adj OR (95% CI)	1 -	1.40 (0.71-2.78)	0.336	1.29 (0.89-1.86)	0.176
- Healthy BMI					
% n	26 (165)	30 (16)		37 (86)	
OR (95% CI)	1 -	1.19 (0.65-2.19)	0.573	1.67 (1.21-2.30)	0.002
Adj OR (95% CI)	1 -	1.30 (0.69-2.43)	0.420	1.79 (1.26-2.54)	0.001
- Healthy diet					
% n	59 (373)	54 (29)		66 (153)	
OR (95% CI)	1 -	0.81 (0.46-1.41)	0.447	1.35 (0.98-1.84)	0.065
Adj OR (95% CI)	1 -	0.80 (0.44-1.44)	0.448	1.30 (0.93-1.82)	0.131
- Alcohol					
% n	52 (331)	54 (29)		50 (115)	
OR (95% CI)	1 -	1.05 (0.60-1.84)	0.851	0.89 (0.66-1.21)	0.465
Adj OR (95% CI)	1 -	1.18 (0.65-2.13)	0.595	1.00 (0.72-1.39)	0.999
- Smoking					
% n	46 (292)	46 (25)		48 (111)	

OR (95% CI)	1 -	1.00 (0.58-1.75)	0.989	1.07 (0.79-1.44)	0.668
Adj OR (95% CI)	1 -	1.16 (0.64-2.10)	0.617	1.19 (0.85-1.65)	0.311

[1] BMI categories: underweight (<18.5 kg/m^2), normal weight (18.5–24.9 kg/m^2), overweight or obese (≥25 kg/m^2).

[†] adjusted for age, education, ethnicity, gestation, and parity.

Supplementary Table 1 Frequencies and associations of pre-conception advice offered to women who had and those who had not visited a health professional for conception advice, across BMI categories[1]

	All	BMI categories			
Outcome % (n)		**Normal Weight**	**Underweight**	**Overweight and Obese**	***P*-value**
Women who sought pre-conception advice	**n=253**	**n=173**	**n=20**	**n=52**	
Any advice of interest	59 (182)	57 (98)	70 (14)	64 (33)	0.402
- Healthy BMI	29 (91)	27 (46)	25 (5)	37 (19)	0.354
- Healthy diet	47 (145)	43 (75)	45 (9)	54 (28)	0.411
- Alcohol	40 (123)	36 (63)	50 (10)	44 (23)	0.351
- Smoking	38 (117)	35 (60)	40 (8)	42 (22)	0.577
Women who did not seek pre-conception advice	**n=840**	**n=446**	**n=33**	**n=174**	
Any advice of interest	15 (126)	11 (51)	6 (2)	22 (39)	-
- Healthy BMI	7 (59)	4 (17)	-	16 (28)	-
- Healthy diet	10 (83)	7 (31)	-	14 (25)	-
- Alcohol	9 (72)	7 (29)	3 (1)	13 (22)	-
- Smoking	9 (71)	6 (28)	3 (1)	12 (21)	-

[1] BMI categories: underweight (<18.5 kg/m^2), normal weight (18.5–24.9 kg/m^2), overweight or obese (≥25 kg/m^2).

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